TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 292

THE AERODYNAMIC LABORATORY

OF THE BELGIAN "SERVICE TECHNIQUE DE L'AERONAUTIQUE."

From "Bulletin du Service Technique de L'Aeronautique,"
May, 1924.

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The 50 cm (19.685 in.) Wind Tunnel.

Before the buildings at Rhode-Saint-Genese were put up, it was arranged that a model of the 2 meter (6.56 ft.) tunnel at 1/4 scale should be made for testing the efficiency of propellers and the improvement of the coefficient of efficiency in aerodynamic wind tunnels, and which could be used later for the calibration of instruments. A description of this reduced model is given here.

Housing.- The 50 cm (19.685 in.) tunnel is installed in a wooden building 15 m (49.2 ft.) in length, 3.75 m (12.3 ft.) in width, and 3.35 m (11 ft.) in clear height (Fig. 1).

The ceiling and inside of the walls are covered with slabs of fibro-cement and the floor is covered with concrete, so that the return flow along the walls shall be as uniform as possible.

There are double doors at each end extending the full width and height of the chamber (Fig. 2).

The chamber has an annex divided into two rooms, one used as an office, the other as a workshop for small jobs that can be done on the spot.

The Tunnel.- The tunnel is placed lengthwise in the center of the chamber and consists, as usual, of an entrance cone, an Eiffel

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experiment chamber, and an exit cone.

The cone-shaped entrance is 1.38 m (4.53 ft.) long, the diameter at the head is 1.50 m (4.92 ft.) and 0.50 m (1.64 ft.) at the entrance to the experiment chamber.

The exit cone is 8 m (26.25 ft.) long. Where it leaves the experiment chamber its diameter is 0.55 m (1.8 ft.) and 1.50 m (4.92 ft.) at the rear in the plane of the propeller.

The walls of the exit cone thus form an angle of $3^\circ\ 30'$ with the axis, giving an opening of 7° at the apex.

The experiment chamber is a cylinder with horizontal axis, 1.20 m (3.94 ft.) long and 1.90 m (6.23 ft.) in diameter (Fig. 3). It is made of riveted sheet-steel plates. The door is also of sheet steel and fits perfectly tight.

The tunnel proper has thus a total length of 1.38 + 1.20 + 8 = 10.58 m (34.71 ft.). It is supported by wooden cradles (Fig. 1) and placed so that its horizontal axis coincides with the axis of the chamber.

The entrance cone is formed of trapezoidal sheets of zinc, tin-soldered and mounted on shaped wooden slats serving as supports (Fig. 4).

The inside of the exit cone is also lined with sheets of soldered zinc supported by slats held together by iron bands.

The exit cone is prolonged into the experiment chamber by a wooden cylinder made in three removable parts. The inner diameter of the cylinder is 0.50 m (1.64 ft.) and the lengths of the parts

are 0.325 m (1.07 ft.), and 0.550 m (1.8 ft.) respectively. When the three parts of the cylinder are assembled, the air stream is confined along its whole length.

Although the experiment chamber is so small, it can easily accommodate one or two operators.

The longitudinal axis of the chamber lies east and west. There are four windows on the south side and two on the north. The annex is on the north side.

The Motor.- The laboratory is supplied with electricity by the "Compagnie Continentale du Gaz" in the form of a three-phase current of 6000 volts at 50 cycles.

After thoroughly studying the matter, it was therefore decided to use a three-phase commutator motor, connected with the system by a single-column transformer.

Both motor and transformer were supplied by the "Ateliers de Constructions Electriques" of Charleroi.

The motor, (Figs. 5 and 6) is of the series type, the rotor being supplied by a transformer. The current is of 220 volts at 50 cycles and the transformer also serves for lighting purposes.

The motor is mounted on two horizontal axes perpendicular to each other oscillating on ball bearings, so that the torque and thrust can be measured. It has an available power of 30 HP at all speeds from 750 to 1500 R.P.M. This is one of the essential characteristics of this type of motor and it was chosen on that account. Its synchronous speed is 1000 R.P.M.

The stator connections consist of very flexible cables, so that they cannot interfere with the torque measurement.

The following are the guaranteed coefficients of efficiency and power:

	Efficiency	$\cos \varphi$
30 HP at 750 R.P.M.	85%	0.85
30 HP at 1000 R.P.M.	86%	0.95
30 HP at 1500 R.P.M.	85%	0.90

Considering the power developed, the motor is small. Its chief dimensions are:

Diameter of armature	330 mm (12.99 in.)
Outer diameter	540 mm (21.26 in.)
Length of armature	190 mm (7.48 in.)
Diameter of commutator	240 mm (9.45 in.)
Length of commutator	140 mm (5.51 in.)

Nine arms with four brushes per arm.

The transformer, inserted between the rotor and stator, serves to reduce the voltage at the commutator, to limit the speed when running free and to multiply the rotor phases of which there are nine. The object of this multiplication is to ensure perfect commutation. It is obtained by an ordinary three-column transformer, combined with suitable shunt windings.

As mentioned above and as shown by Figs. 5 and 6, the motor is mounted on two horizontal axes perpendicular to each other about which it can oscillate on ball bearings. For measuring the torque, the motor stand is provided with a lever one meter long, on the end

of which there is a disk for receiving the weights. The reading is obtained by balancing. Checking is facilitated by the fact that there are two lamps which light automatically, one or the other, according to the direction in which the motor tips.

Propeller thrust is obtained in the same way, by means of weights placed on a disk hung behind the motor.

The oscillations of the motor are limited by adjustable stops at short distances from one another.

The fan may have 2, 3, 4, 6, 8 or 12 blades (Fig. 7). The blades are provided with conical tenons fitted tightly between the two halves of the hub. This arrangement allows the inclination of the blades to their plane of rotation to be varied easily while at rest.

The motor stand (Figs. 5 and 6) is of cast iron. A stand of this type was used in some têsts for the purpose of rendering symmetrical the obstacles to the flow of the air behind the propeller.

The tunnel can function with the doors of the building either closed or open, that is, with or without return flow.

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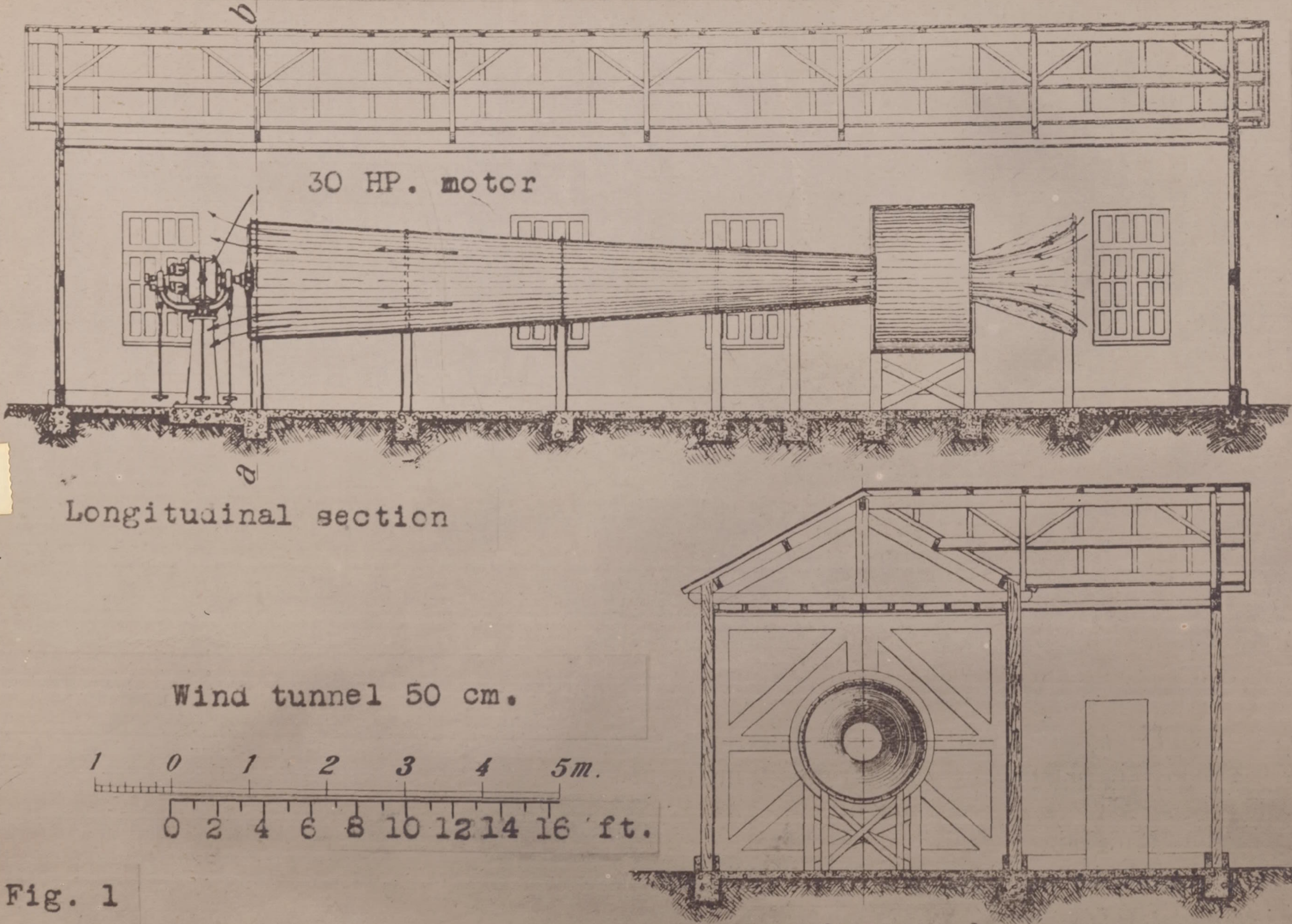

Longitudinal section

Section a - b

Wind tunnel 50 cm.

Fig. 1

Fig.2

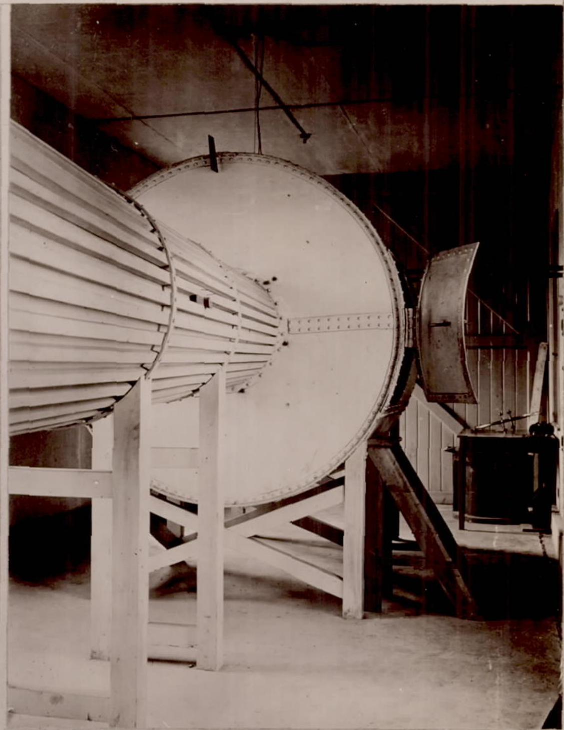

Fig.3

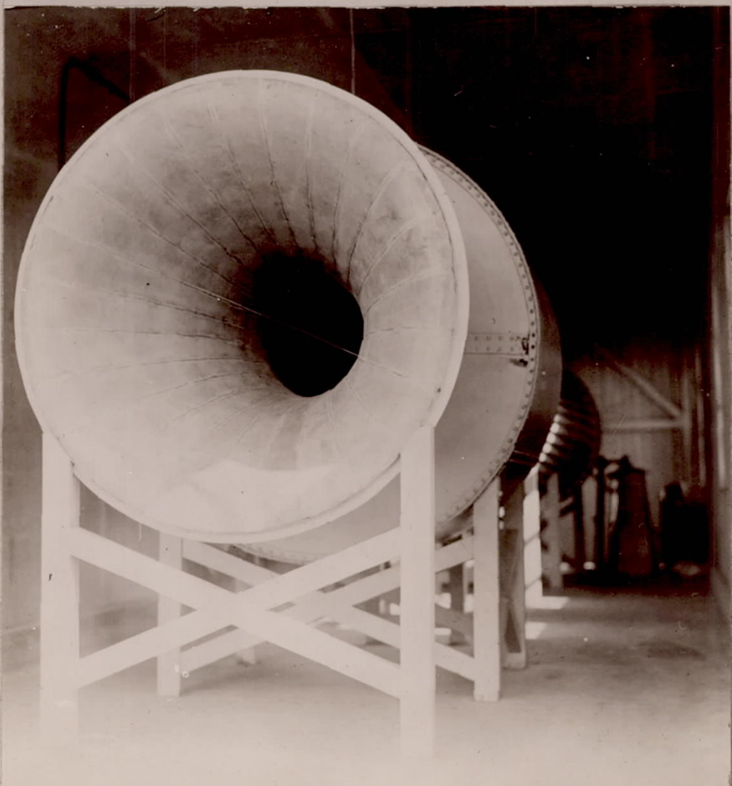

Fig.4

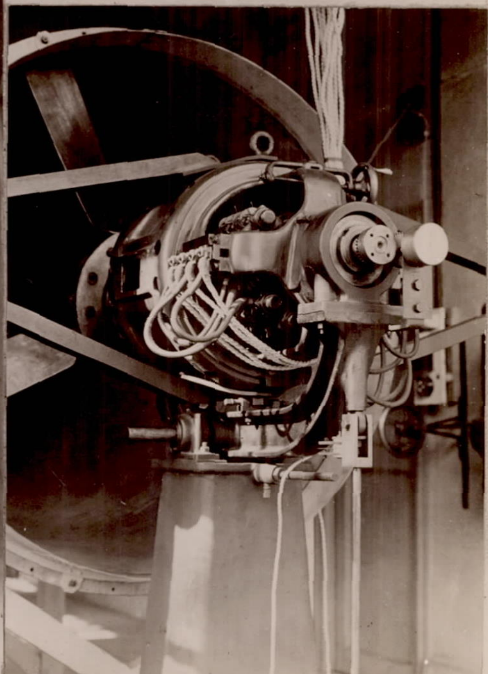

Fig.5

Reduce to 19 inches Photograph

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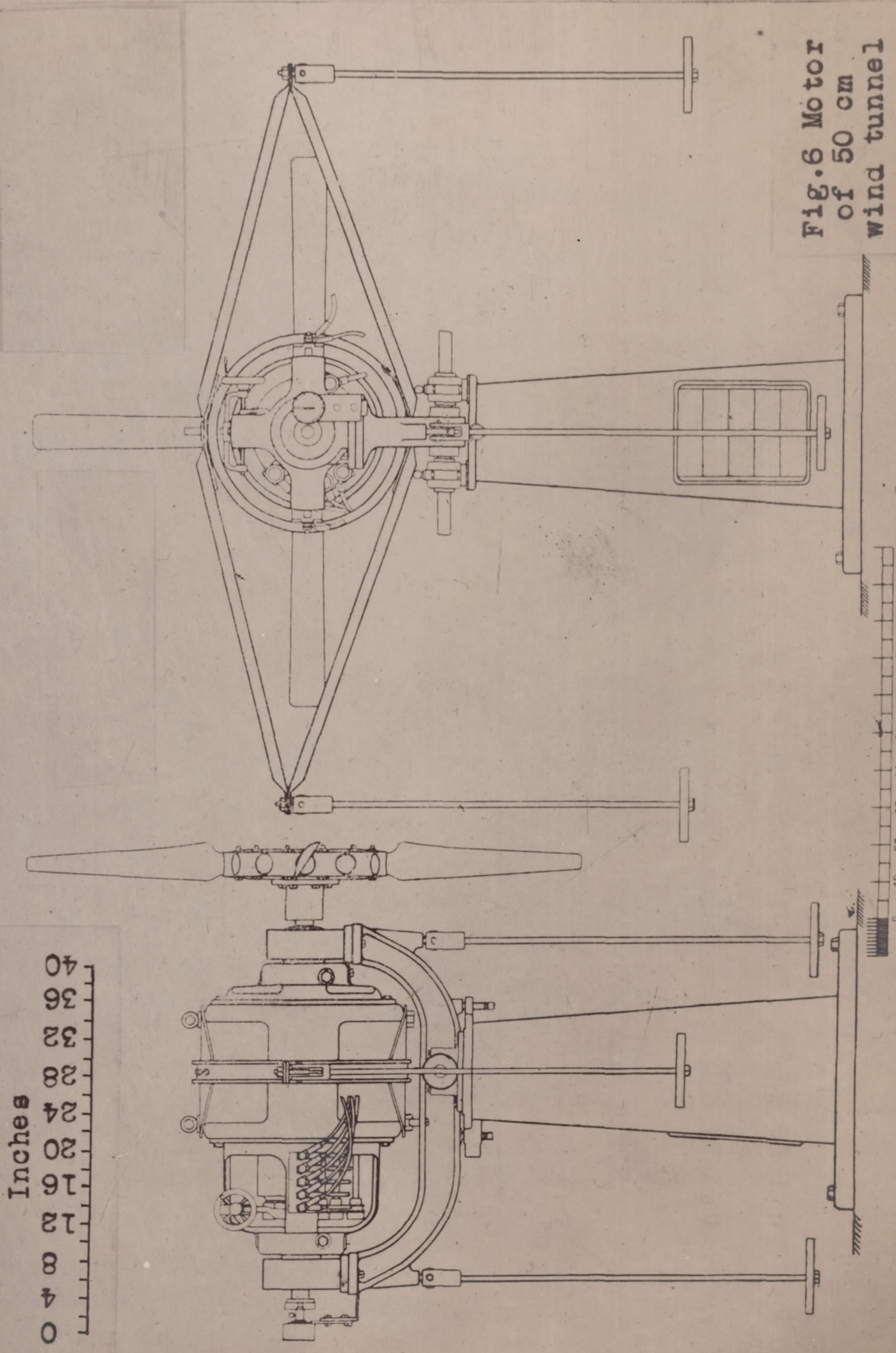

Fig.6 Motor of 50 cm wind tunnel

X=745 mm (29.33 in.)

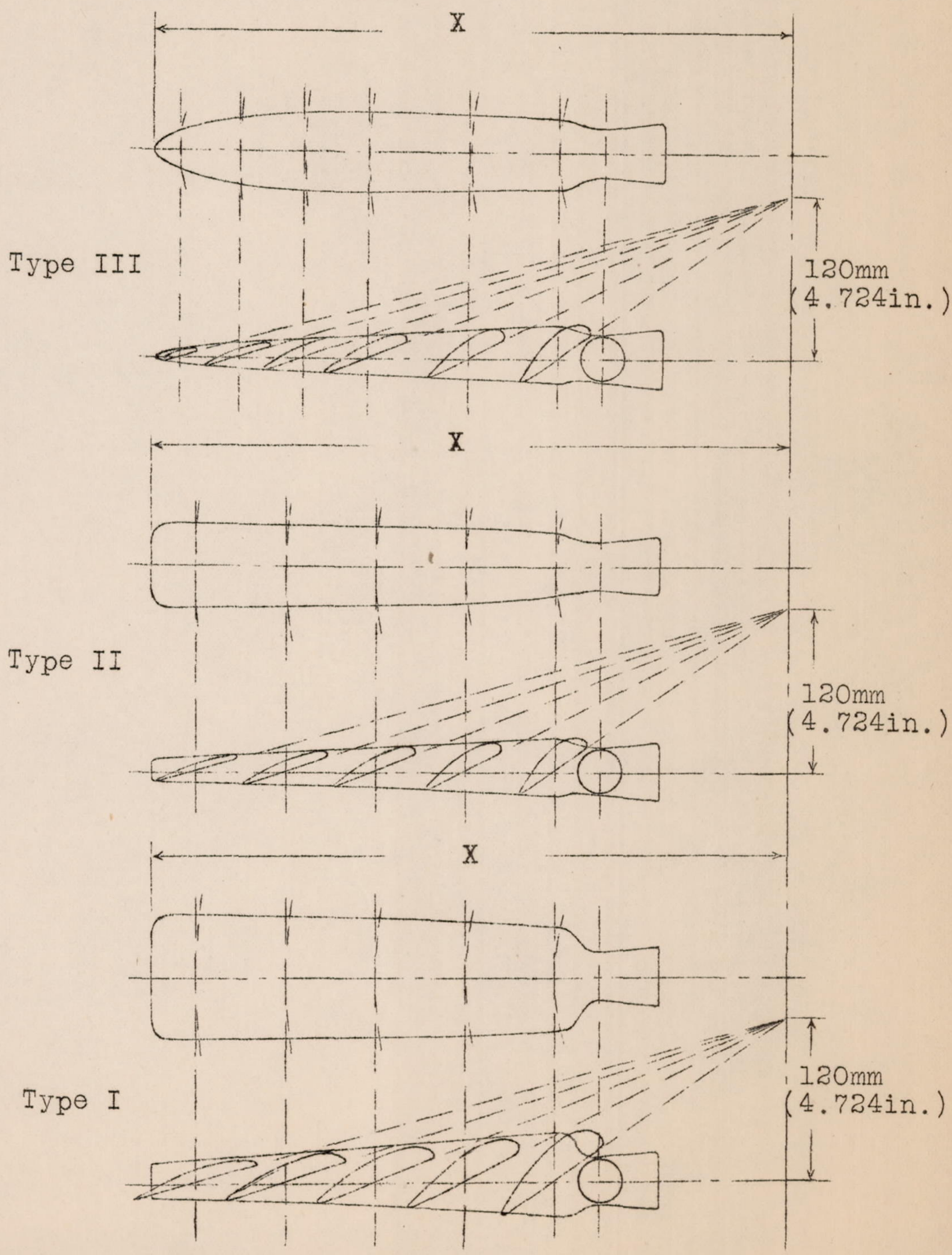

Fig.7. Propeller blades of 50cm wind tunnel.